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MICHELE C. FARQUHAR
PARTNER
(202) 637-5663
MCFARQUHAR@HHLAW.COM

COLUMBIA SQUARE
555 THIRTEENTH STREET, NW
WASHINGTON, DC 20004-1109
TEL (202) 637-5600
FAX (202) 637-5910
WWW.HHLAW.COM

June 22, 2004

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

RE: WT Docket No. 03-103
Notice of *Ex Parte* Presentation

Dear Ms. Dortch:

This is to inform you that AirCell, Inc. ("AirCell") made an *ex parte* presentation on June 21, 2004 with respect to the above-referenced proceeding. AirCell representatives Joe Cruz and Bill Gordon, as well as AirCell consultants Ivica Kostanic, Ph.D., Assistant Professor at Florida Institute of Technology, Grant Saroka, Saroka & Associates, and I met with the following Wireless Telecommunications Bureau ("WTB") staff: David Furth, Shellie Blakeney, Kathy Harris, Guy Benson, Jay Jackson, Tom Derenge, and the following representatives from the Office of Engineering and Technology ("OET"): Ed Thomas, Julius Knapp, Jim Schlichting, George Sharp, Shameeka Hunt and Ahmed Lahjouji.

The presentation discussed the points set forth in AirCell's comments and reply comments in the Air-Ground proceeding, including further detail concerning AirCell's technical presentations of January 14 and March 10, 2004. Specifically, AirCell presented the attached slides to demonstrate how restructuring the ATG band would permit up to four air-ground service providers. As outlined in the slides, Dr. Kostanic described AirCell's use of various isolation methods to facilitate spectrum sharing in the ATG band, including cross-duplex operation, polarization isolation, partial channel overlap, and deployment of smarter antennas.

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List ABCDE

Pursuant to Section 1.1206(b)(1) of the Commission's rules, I am filing an original and one copy in the above-referenced docket. In addition, I am sending one copy of this notice to each of the FCC staff listed below. Please contact me directly with any additional questions.

Respectfully submitted,

Michele C. Farquhar
Counsel to AirCell, Inc.

Enclosures

cc: David Furth
Shellie Blakeney
Guy Benson
Kathy Harris
Jay Jackson
Tom Derenge
Ed Thomas
Julius Knapp
Jim Schlichting
George Sharp
Shameeka Hunt
Ahmed Lahjouji

AirCell

Evaluation of ATG Spectrum Migration Concept (part 2)

Presentation to FCC

Prepared by

AirCell
Global Airborne Telecommunication

June 21, 2004

Presentation Outline

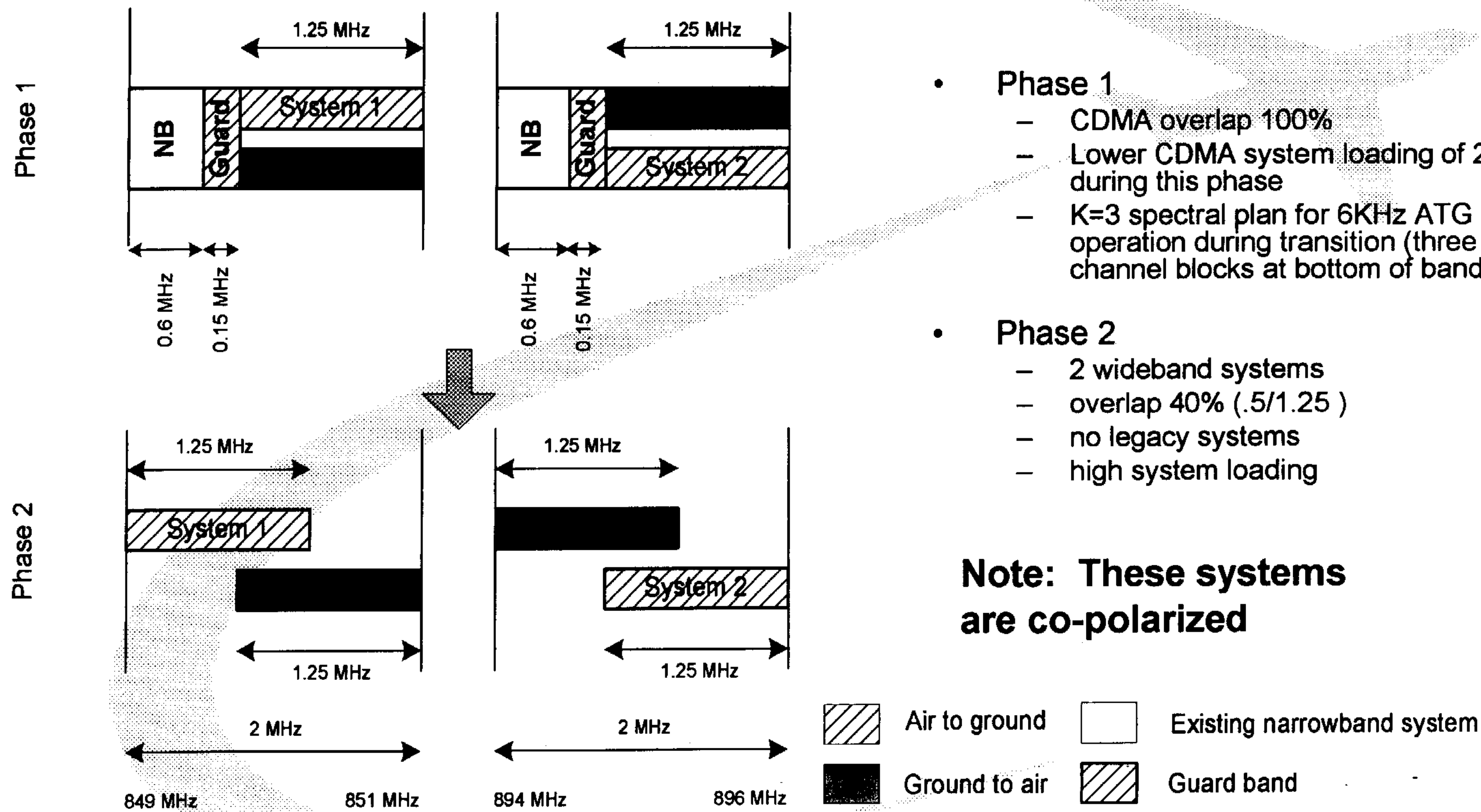
- Introduction
- Isolation mechanisms for ATG spectrum sharing
- Spectrum allocation plains for deployment of four CDMA systems
- Simulation description
- Summary and conclusions

Introduction

- Purpose
  - Evaluate different possibilities for ATG spectrum migration
  - Examine theoretical and practical issues for spectrum sharing between four systems
    - Likelihood of harmful interference
    - Impact of the interference on capacity
    - Methods for interference mitigation
    - Compatibility with existing systems
  - Propose efficient and cost effective utilization of ATG spectrum
- Method
  - Analysis by simulation – Monte Carlo approach
  - Developed sophisticated Matlab-based system simulation tools
  - Simulation results compared/checked with theoretical bounds

Outline of the previous AirCell proposal

AirCell



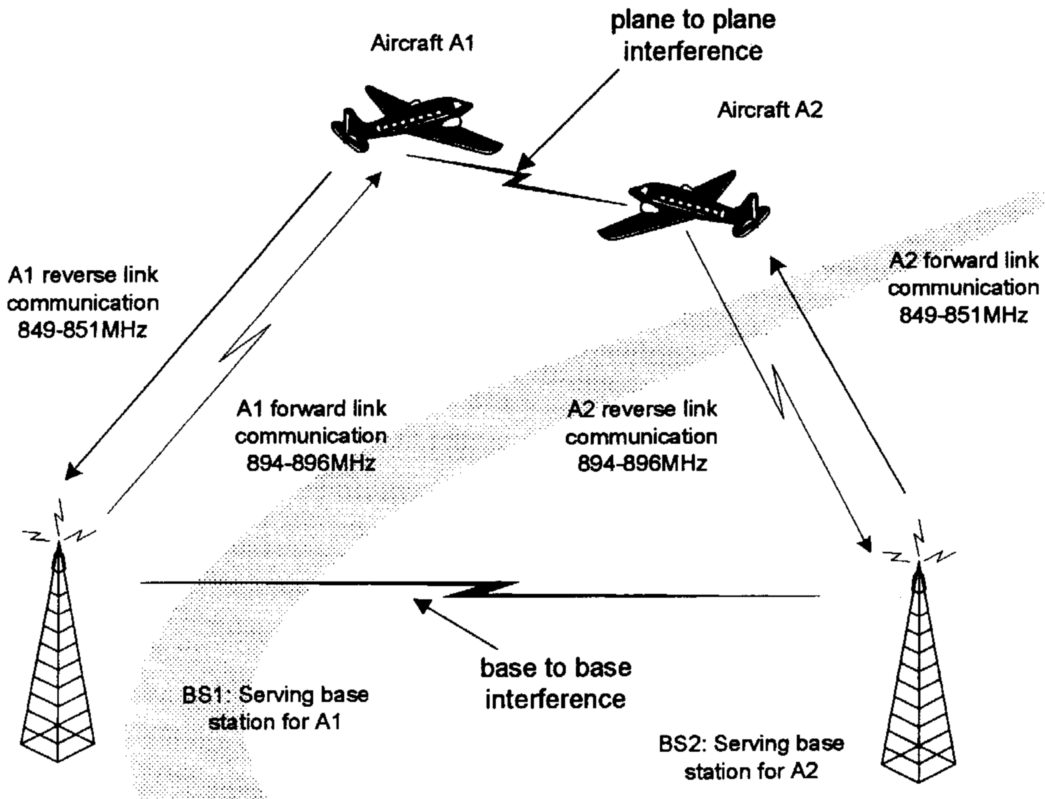
- Phase 1
  - CDMA overlap 100%
  - Lower CDMA system loading of 25% during this phase
  - K=3 spectral plan for 6KHz ATG operation during transition (three channel blocks at bottom of band)
- Phase 2
  - 2 wideband systems
  - overlap 40% (.5/1.25)
  - no legacy systems
  - high system loading

Note: These systems are co-polarized

Isolation methods used in ATG spectrum sharing

- Cross-duplex operation
- Polarization isolation
- Partial channel overlap
- Deployment of “smarter” antennas
  - Null filling
  - Beam switching
  - Beam steering

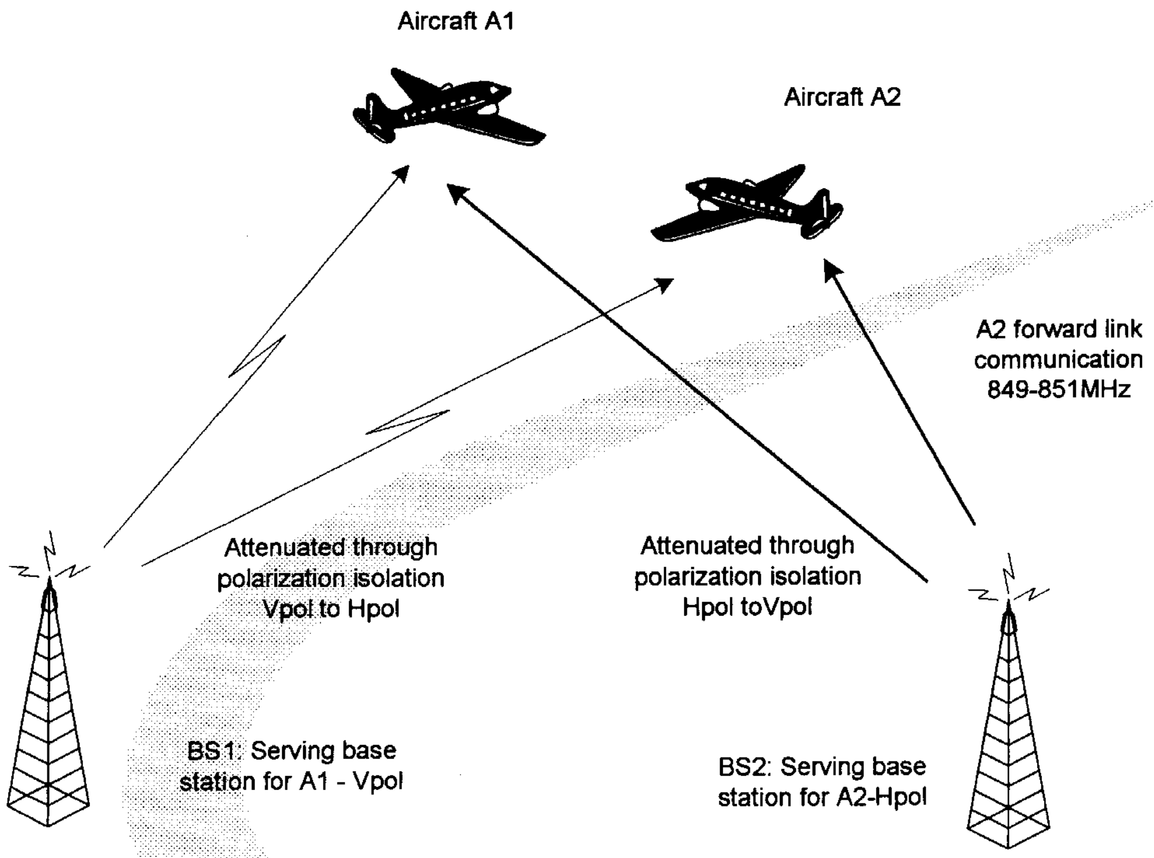
Interference avoidance through cross-duplex operation



- Reason for interference in ATG spectrum – frequency overlap between the systems
- Interference paths in cross-duplex operation
  - Reverse link of one system to forward link of the other (aircraft to aircraft)
  - Forward link of one system to reverse link of the other (base to base)
- Base to base interference – easily controlled by physical separation and antenna patterns
- Previous AirCell reports analyzed swapped spectrum interference

Cross duplex operation switches transmit and receive bands for the two systems

Interference avoidance through polarization isolation

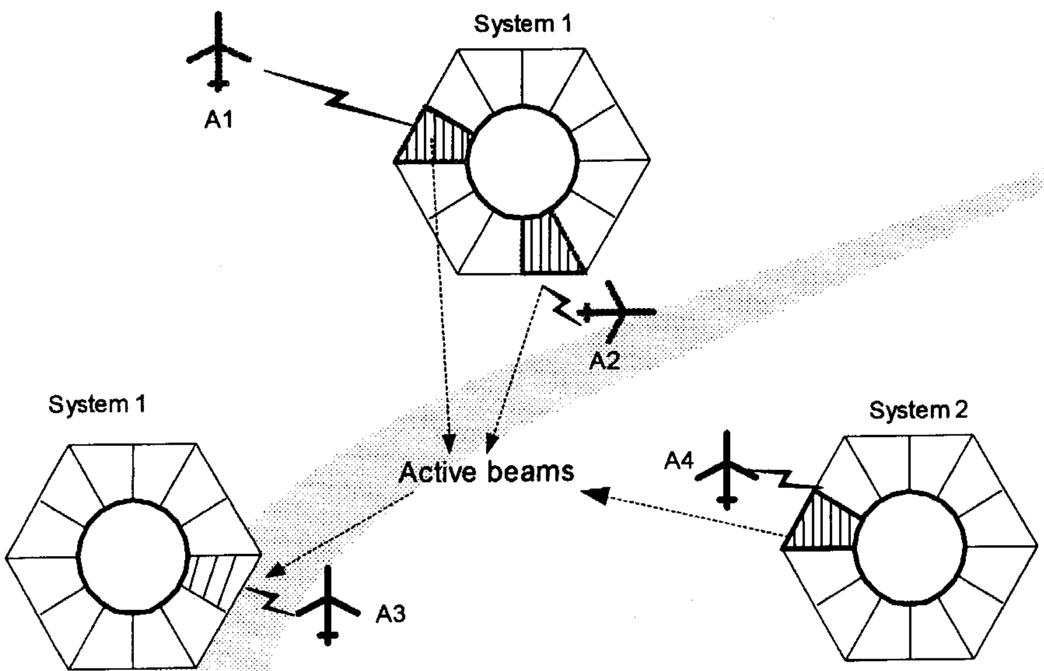


- Interference paths:
  - FWD to FWD and
  - REV to REV
- Interference reduced by polarization isolation
- Interference occurs both on FWD and REV link
- Not the same on Pilot and FWD link traffic channel
- REV link interference – "near-far" problem

Illustration of forward link interference on co-duplex, cross-polarized systems

AirCell

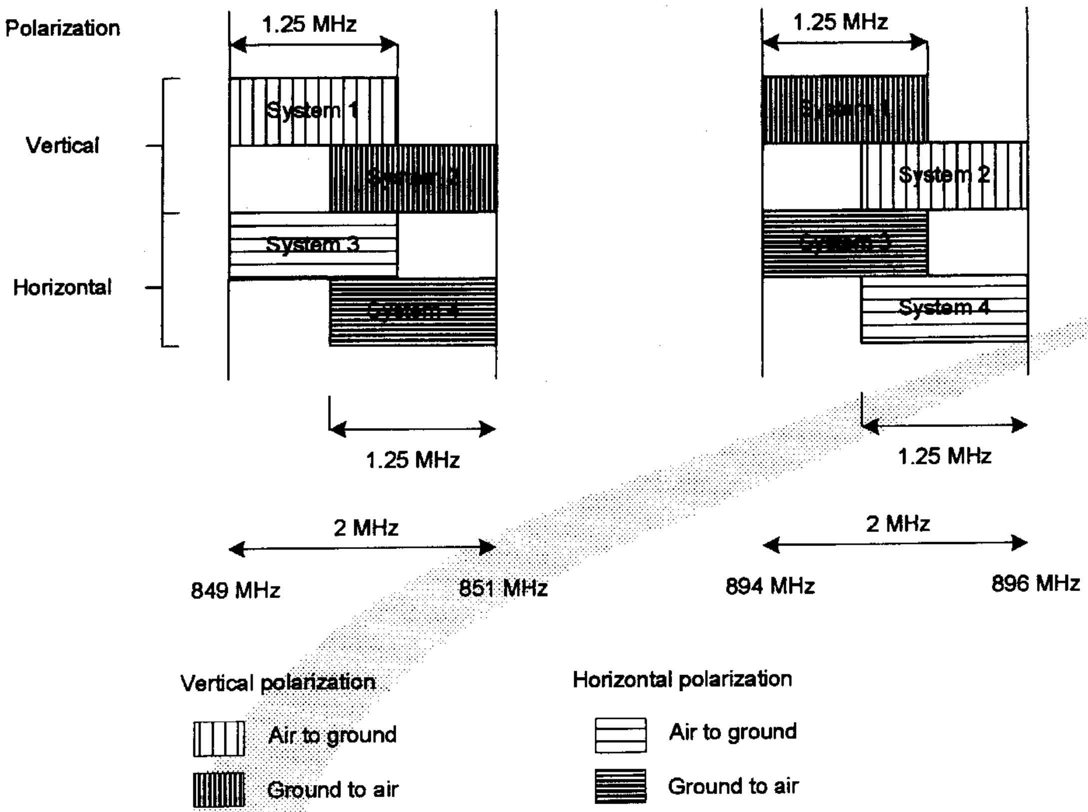
Interference avoidance through beam switching



Beam switching reduces interference on both communication links

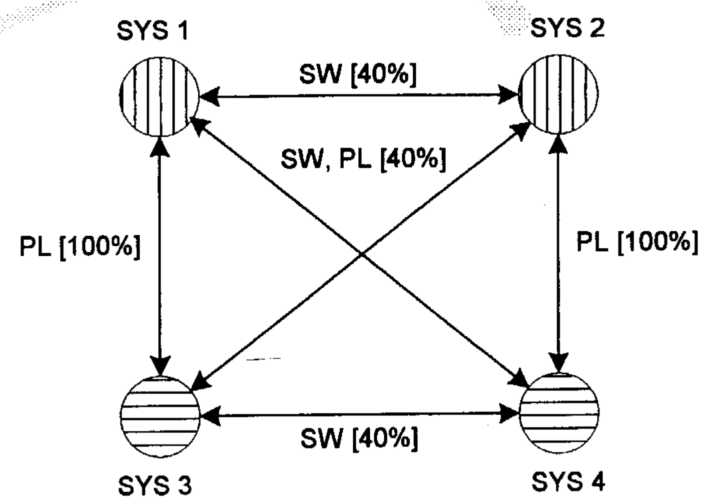
- Antenna system on the base deploys multiple switch beams
- Radiation / reception – only in limited portion of space
- Traditional approach – switching in the horizontal plane
- ATG deployment is 3D – switching may be used in vertical plane
- More effective in combating FWD link interference

Spectrum Plan - 1



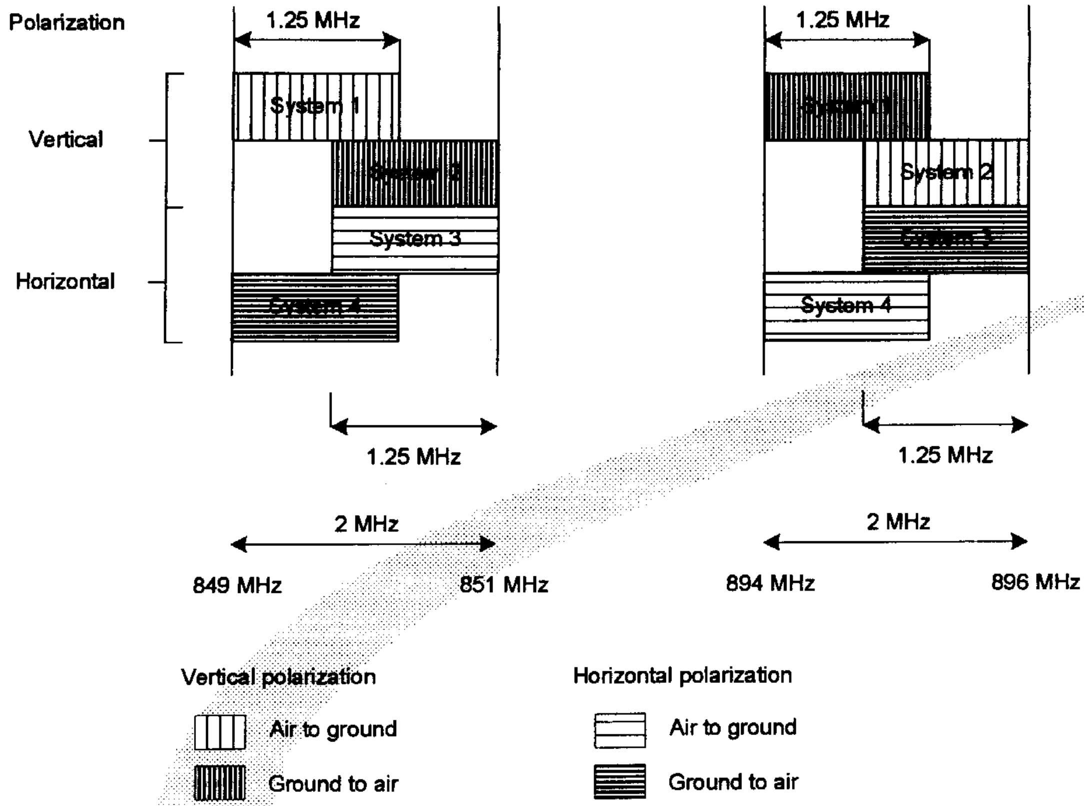
Frequency allocation for Plan 1

- Four systems
- V pol – 2 systems
- H pol – 2 systems



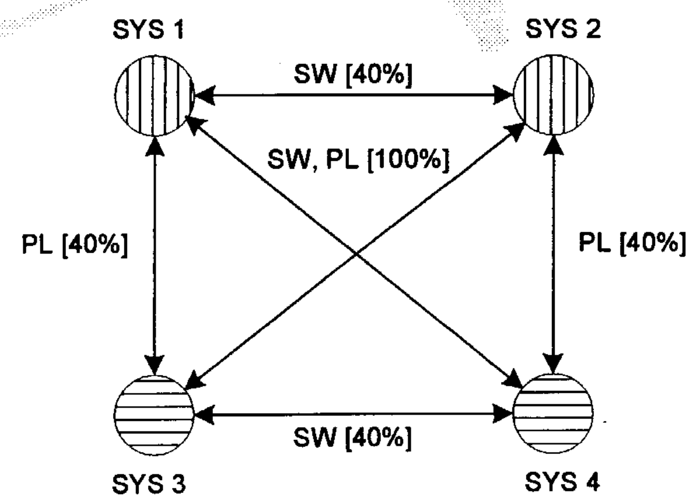
- same color – spectrum collocate
- same pattern – same polarization
- SW – switched spectrum
- PL – polarization isolation
- [x%] – percent of spectrum overlap

Spectrum Plan - 2



Frequency allocation for Plan 2

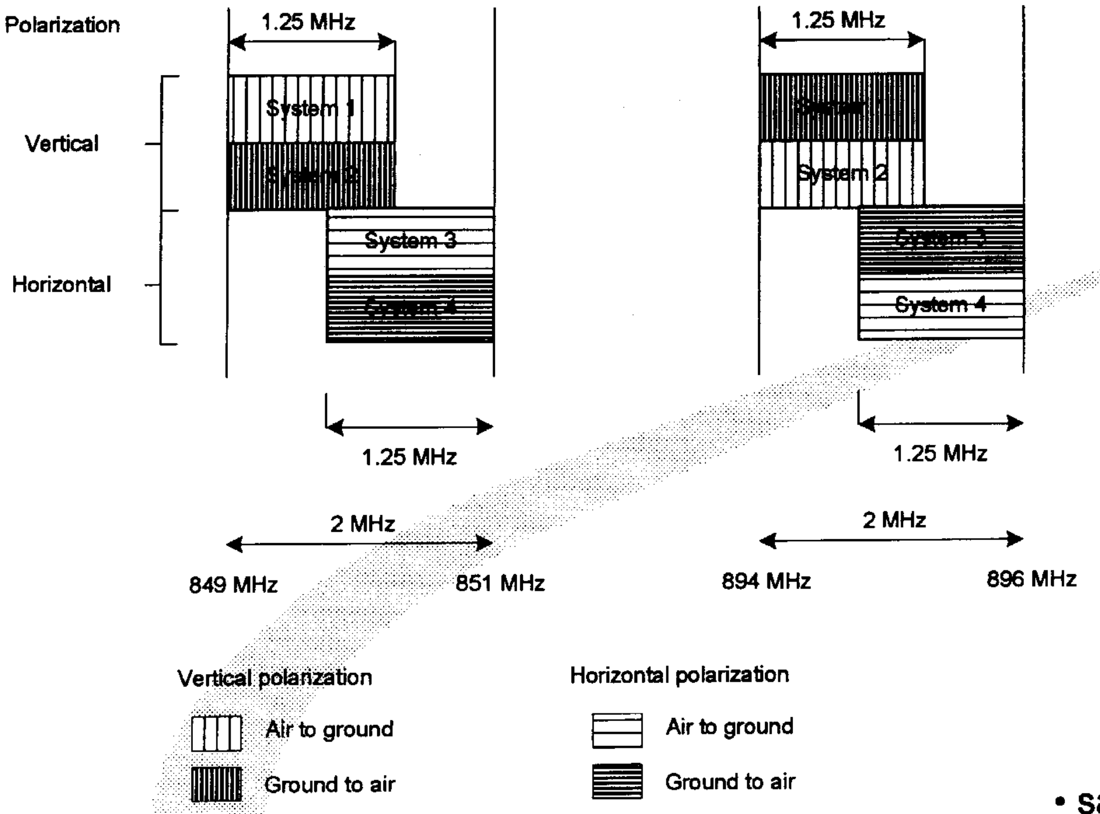
- Four systems
- V pol – 2 systems
- H pol – 2 systems



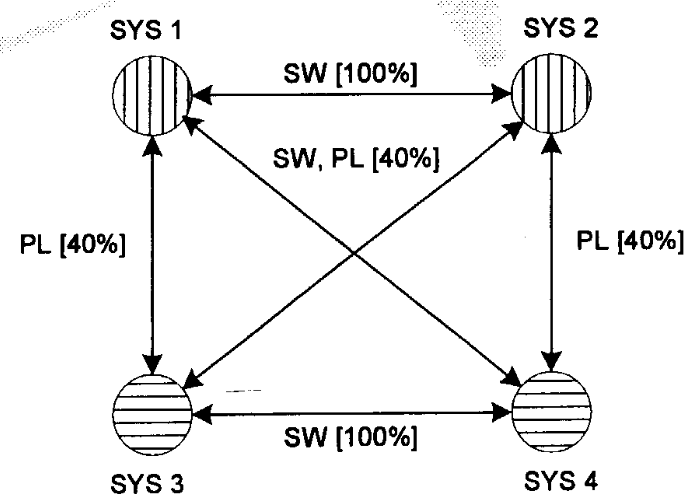
- same color – spectrum collocate
- same pattern – same polarization
- SW – switched spectrum
- PL – polarization isolation
- [x%] – percent of spectrum overlap

Spectrum Plan - 3

- Four systems
- V pol – 2 systems
- H pol – 2 systems



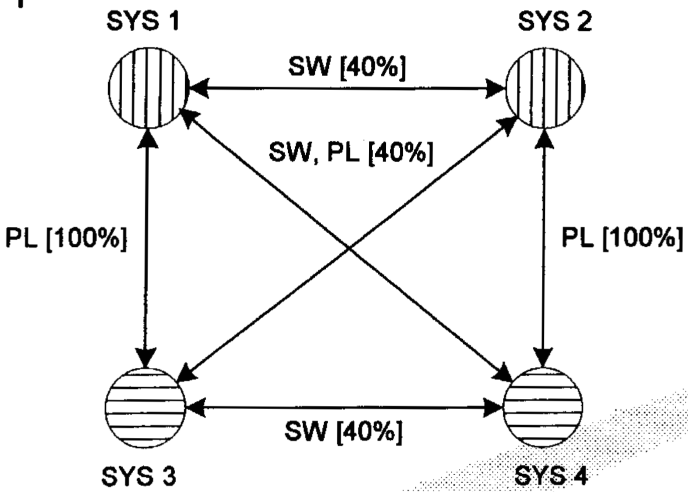
Frequency allocation for Plan 3



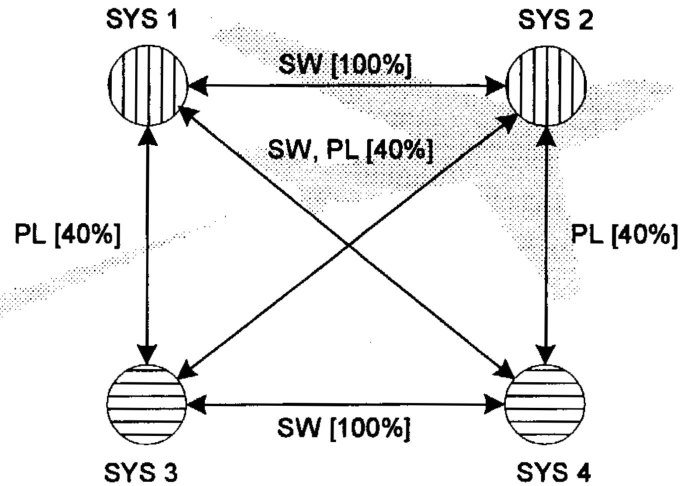
- same color – spectrum collocate
- same pattern – same polarization
- SW – switched spectrum
- PL – polarization isolation
- [x%] – percent of spectrum overlap

Spectrum plan -summary

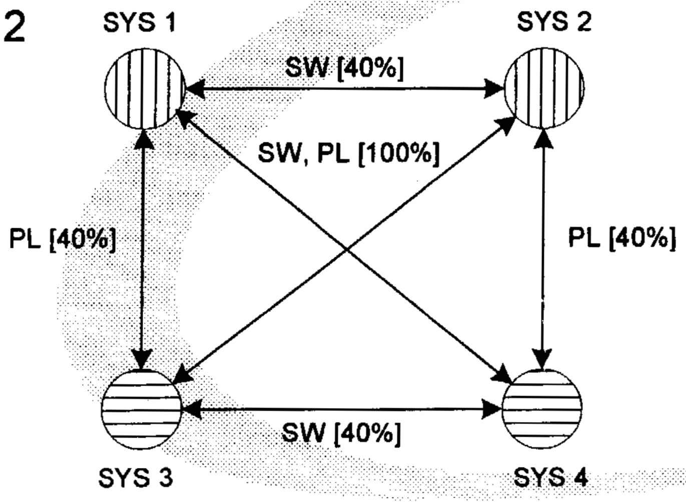
Plan 1



Plan 3

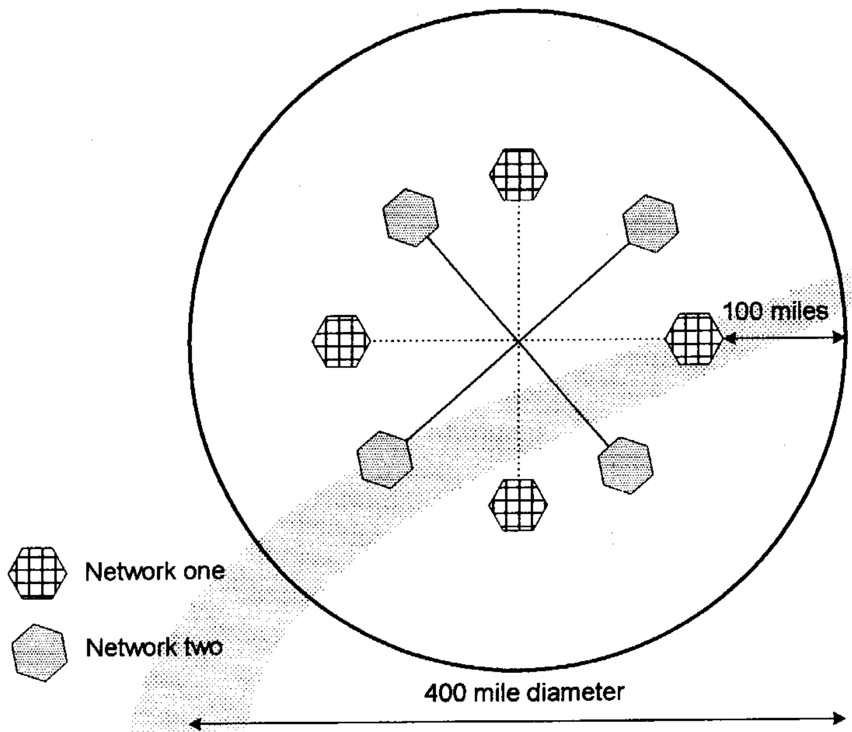


Plan 2



- <u>"Horizontal" interference</u> –swapped spectrum systems – Analyzed in FCC report (March 10)
- <u>"Diagonal' interference</u> – negligible
- <u>"Vertical" interference</u> – non-swapped systems with different polarization
  - Two cases – 40% and 100% of spectrum overlap
- The most favorable allocation – Plan 2 (40% overlap)
- Allows migration of existing systems – Plan 3

Cross Country
co-duplex, cross-polarization simulator



Topology of the inter-system test bed for cross-country scenario

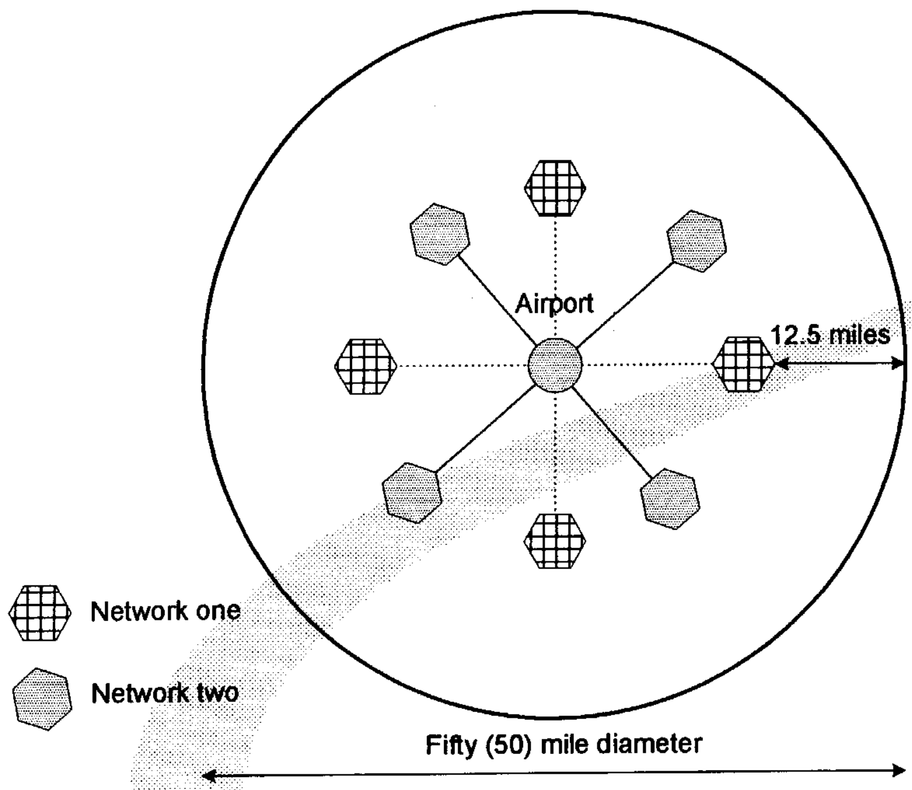
- Simulation parameters
  - Omni-directional sites
  - One network H-pol, other network V-pol
  - Antenna patterns with null fills (no nulls more than 20dB below the peak)
  - Altitudes 18,000 – 40,000 feet
  - Average of 10 voice calls per plane
  - Three different loading scenarios

Mapping between system loading and the number of supported aircraft

Loading [%]	Number of aircraft
25	4
50	8
75	12

Airport Scenario

co-duplex, cross-polarization simulator



Topology of the inter-system test bed for airport scenario

- Simulation parameters
  - Three sectored sites
  - One network H-pol, other network V-pol
  - 120 degrees pattern with null fills (no nulls more than 20dB below the peak)
  - Altitudes 1000 – 40,000 feet
  - 10 voice calls per plane
  - Three different loading scenarios

Mapping between system loading and the number of supported aircraft

Loading [%]	Number of aircraft
25	12
50	24
75	36

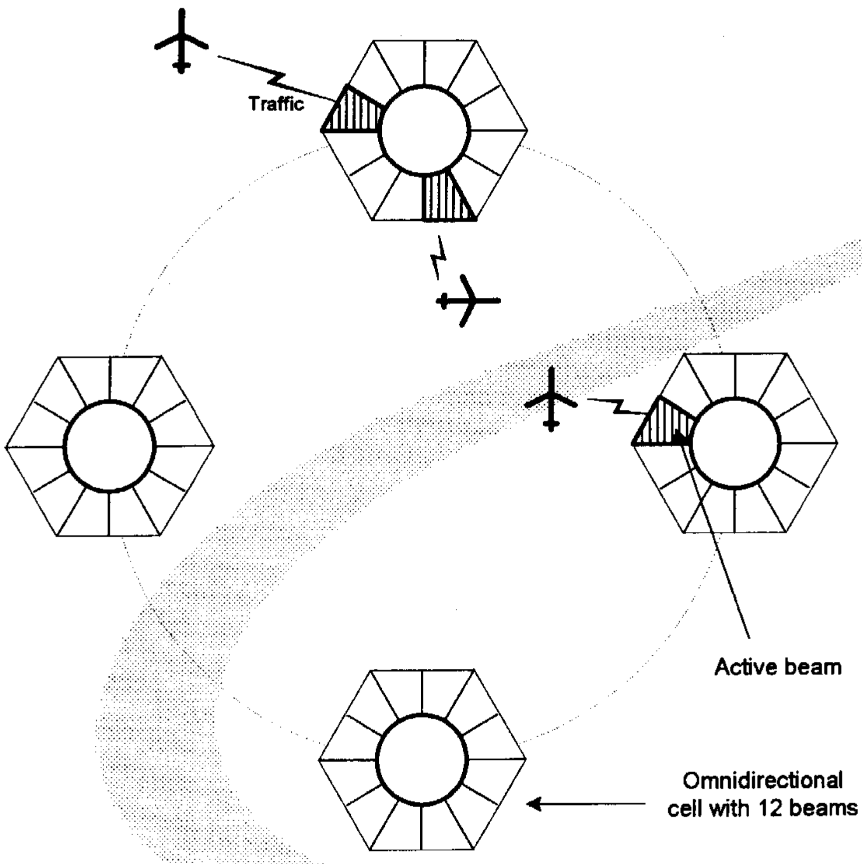
General simulation parameters

AirCell

Parameter	Value	Unit	Description
SIM_TIME	7200	Seconds	Duration of the simulation time
TIME_STEP	1	Seconds	Increment of the simulation time
f	870	MHz	Average operating frequency
NumCallsAC	10	-	Average number of voice calls per aircraft of the first system
NumCallsAF	10	-	Average number of voice calls per aircraft of the second system
W	1.2288e6	-	Chip rate for 1xEvDO system
Zmin	1000^1, 18000^2	feet	Minimum aircraft altitude
Zmax	40000	feet	Maximum aircraft altitude
Vmin	380^2, 180^1	knots	Minimum velocity of the aircraft
Vmax	450^2, 250^1	knots	Maximum velocity of the aircraft
MinVerSep	1500	feet	Minimum vertical separation between aircraft
MinHorSep	5	miles	Minimum horizontal separation between aircraft
VAF	0.5	-	Average voice activity
FL_IF_Scaling	$0.5/1.25^3$, 1^4	-	Scaling of the interference due to partial overlap
BS.PA_power	20	W	Base station transmit power
BS.NF	4	dB	Base station noise figure
BS.DL_CL	3	dB	Forward link cable losses
BS.UL_CL	3	dB	Reverse link cable losses
MS.PA_power	23	dBm	Mobile station transmit power
MS.NF	8	dB	Noise figure of the mobile
MS.EbNt	4	dB	Required Eb/Nt for the reverse link
R	12.5^1, 100^2	miles	Cell site radius, c.f. Fig. 5

^{1} – airport scenario; ^{2} – cross-country scenario
^{3} – 40% spectrum overlap; ^{4} – 100% spectrum overlap

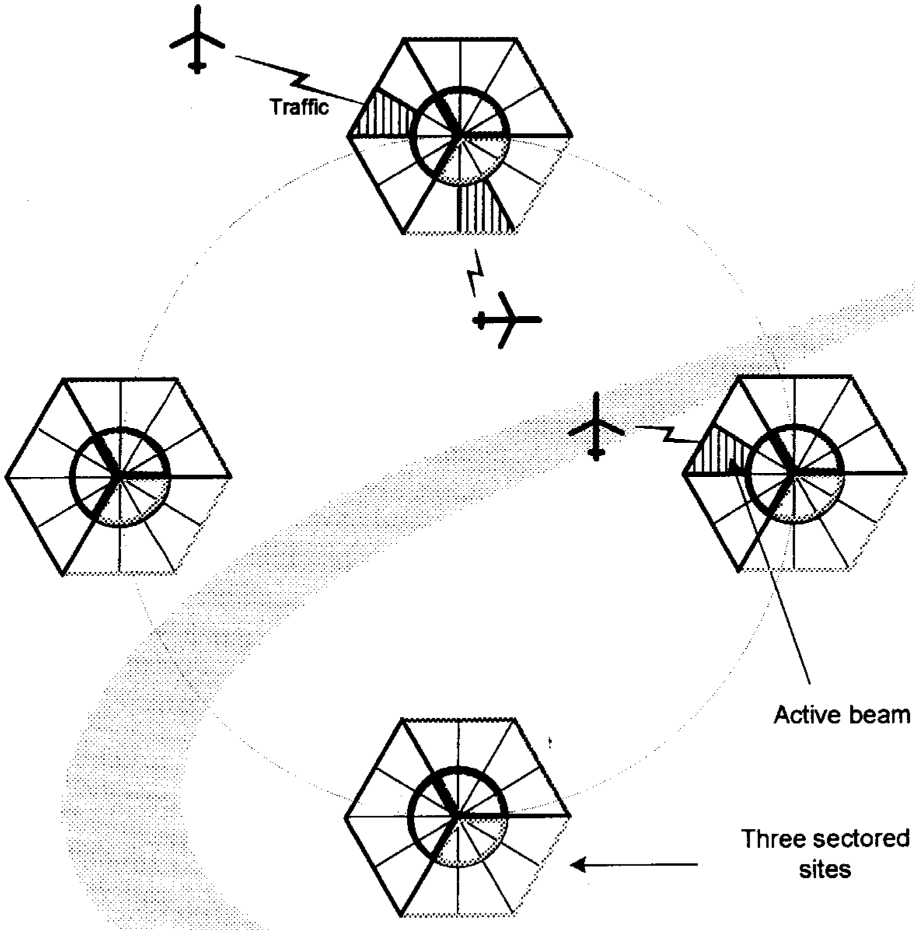
Beam switching – cross country scenario



Switched beam architecture – CC scenario

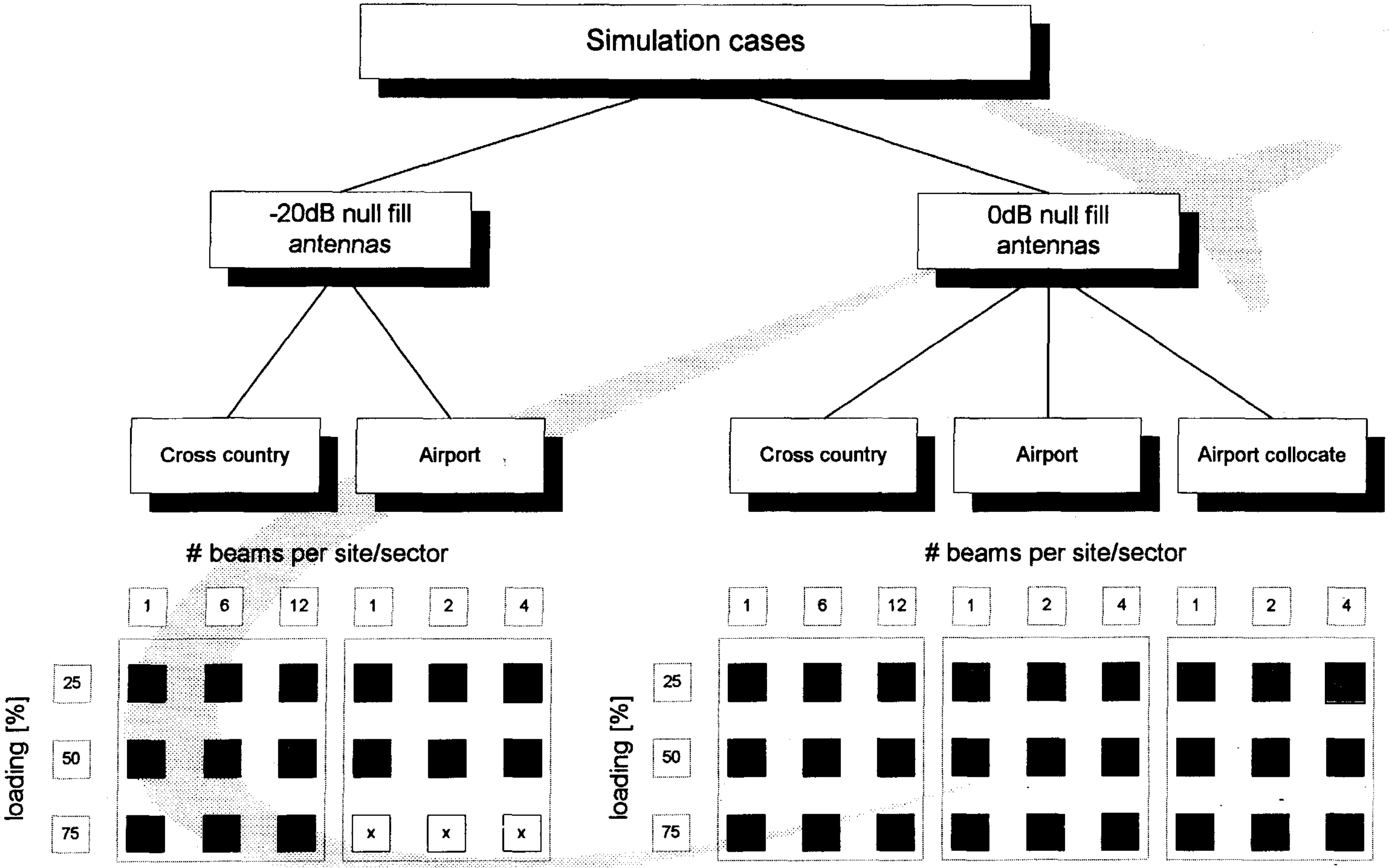
- Omni sites
- 1, 6 or 12 beams per site
- Omni-directional pilot transmission
- On traffic channel – TX and RX through one beam
- Vertical patterns
  - 6 deg of beamwidth,
  - 4.5 deg of uptilt,
  - -20dB antenna fill - patterns

Beam switching – airport scenario

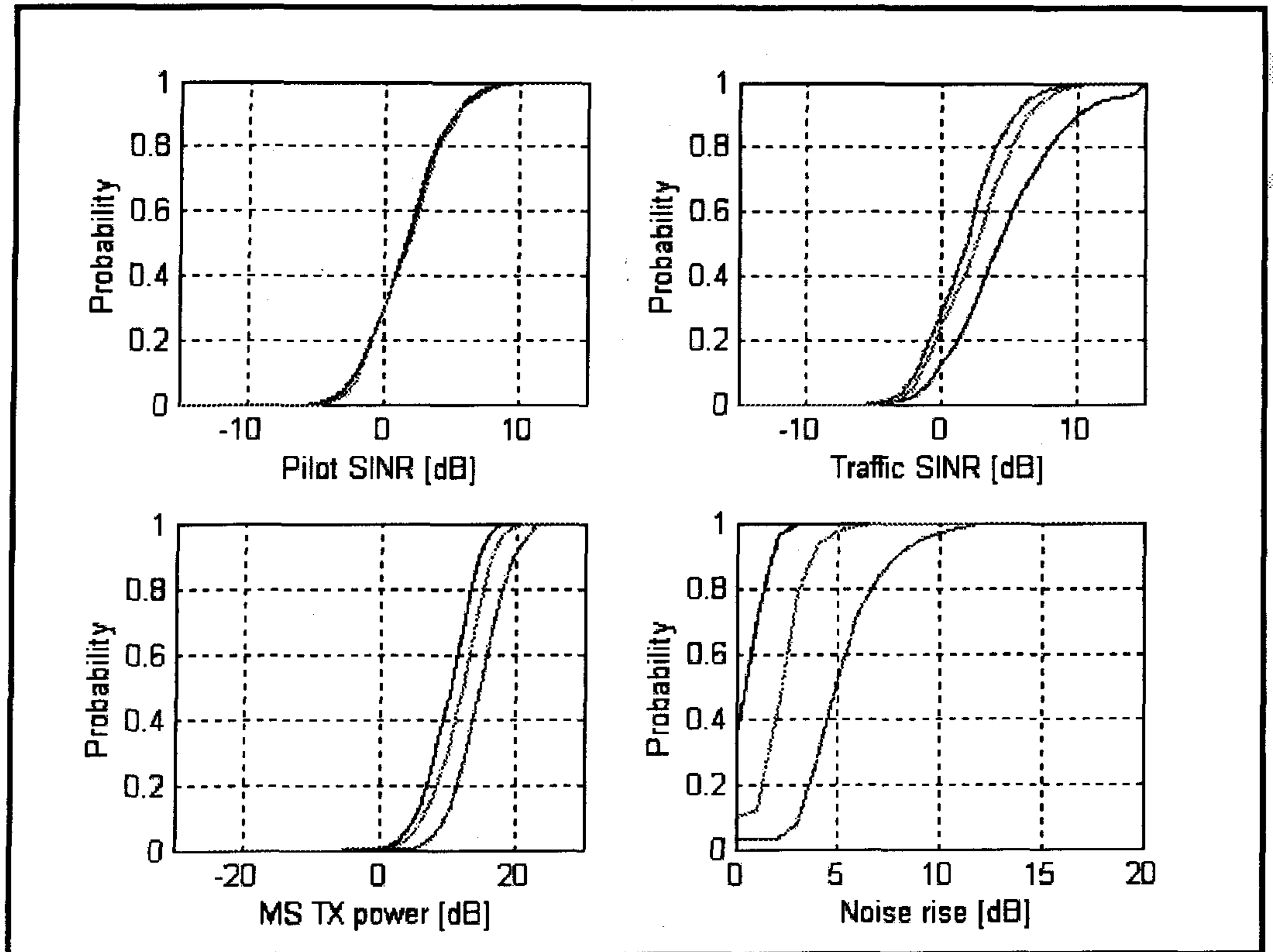


Switched beam architecture – Airport scenario

- Sectorized sites
- 1, 2 or 4 beams per sector
- Sectorized pilot transmission (120 deg)
- On the traffic channel – TX and RX through one beam
- Vertical patterns
  - 6 deg of beamwidth
  - 4.5 deg of uptilt
  - -20dB and 0dB null fill


Simulation cases
-20dB null fill antennas
0dB null fill antennas
Cross country
Airport
Cross country
Airport
Airport collocate
beams per site/sector
beams per site/sector
1
6
12
1
2
4
1
6
12
1
2
4
1
2
4
loading [%]
25
50
75
loading [%]
25
50
75
x
x
x

Results – cross country [40%]



Cross country – 1 beam per cell (omni), 40% spectrum overlap, blue – 25% loading, green - 50% loading, red – 75% loading

- Polarization isolation – 12dB
- 25% loading – 4 aircraft/system
- 50% loading - 8 aircraft/system
- 75% loading – 12 aircraft/system
- Used –20dB null fill antennas

Loading [%]	# of aircraft
25	16
50	32
75	48

Results – cross country [40%]

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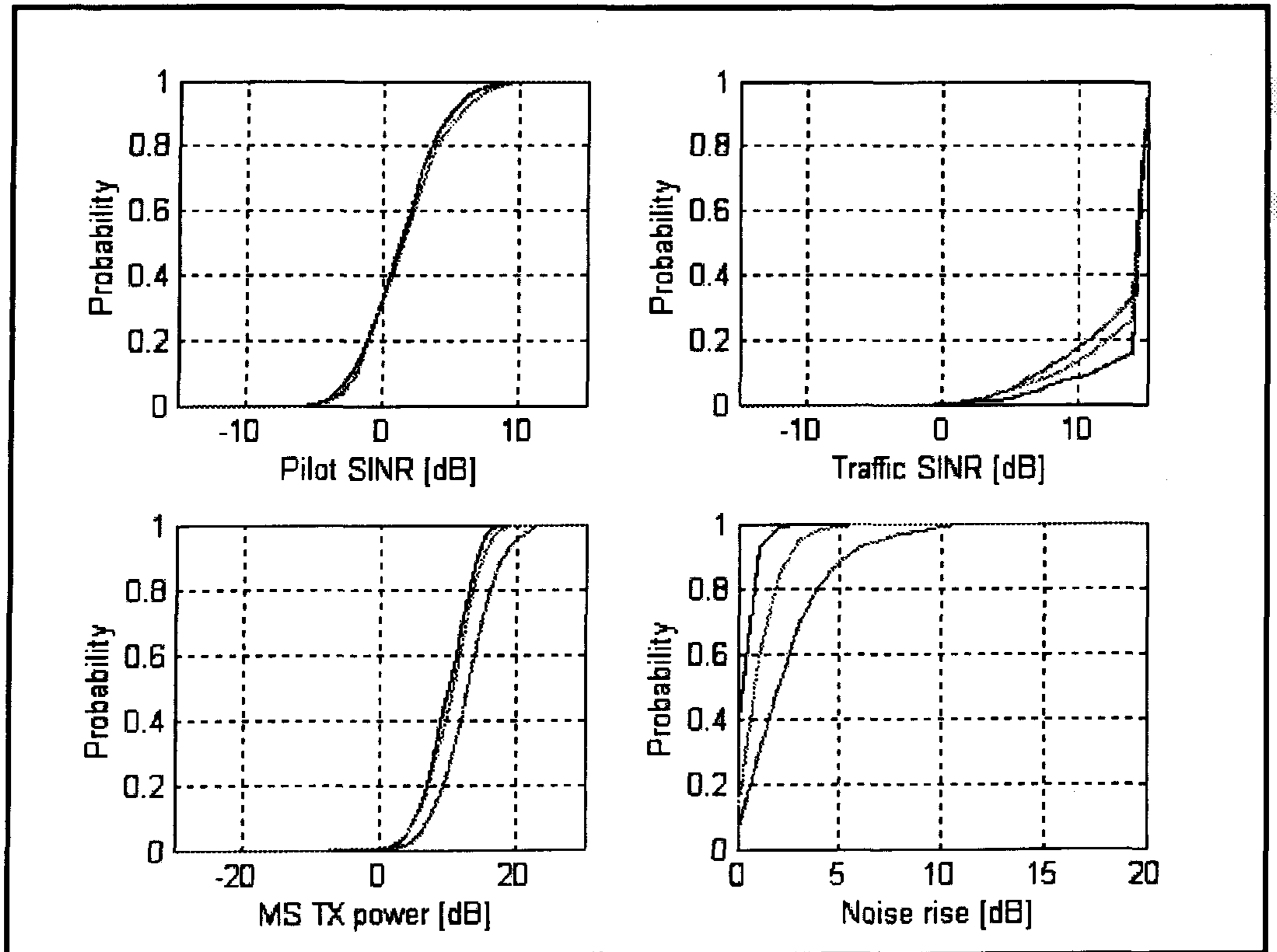


Cross country – 12 beam per cell (omni), 40% spectrum overlap, blue – 25% loading, green - 50% loading, red – 75% loading

- Polarization isolation – 12dB
- 25% loading – 4 aircraft/system
- 50% loading - 8 aircraft/system
- 75% loading – 12 aircraft/system
- Used –20dB null fill antennas

Loading [%]	# of aircraft
25	16
50	32
75	48

Results - summary of cross-country scenario

AirCell

No beam switching

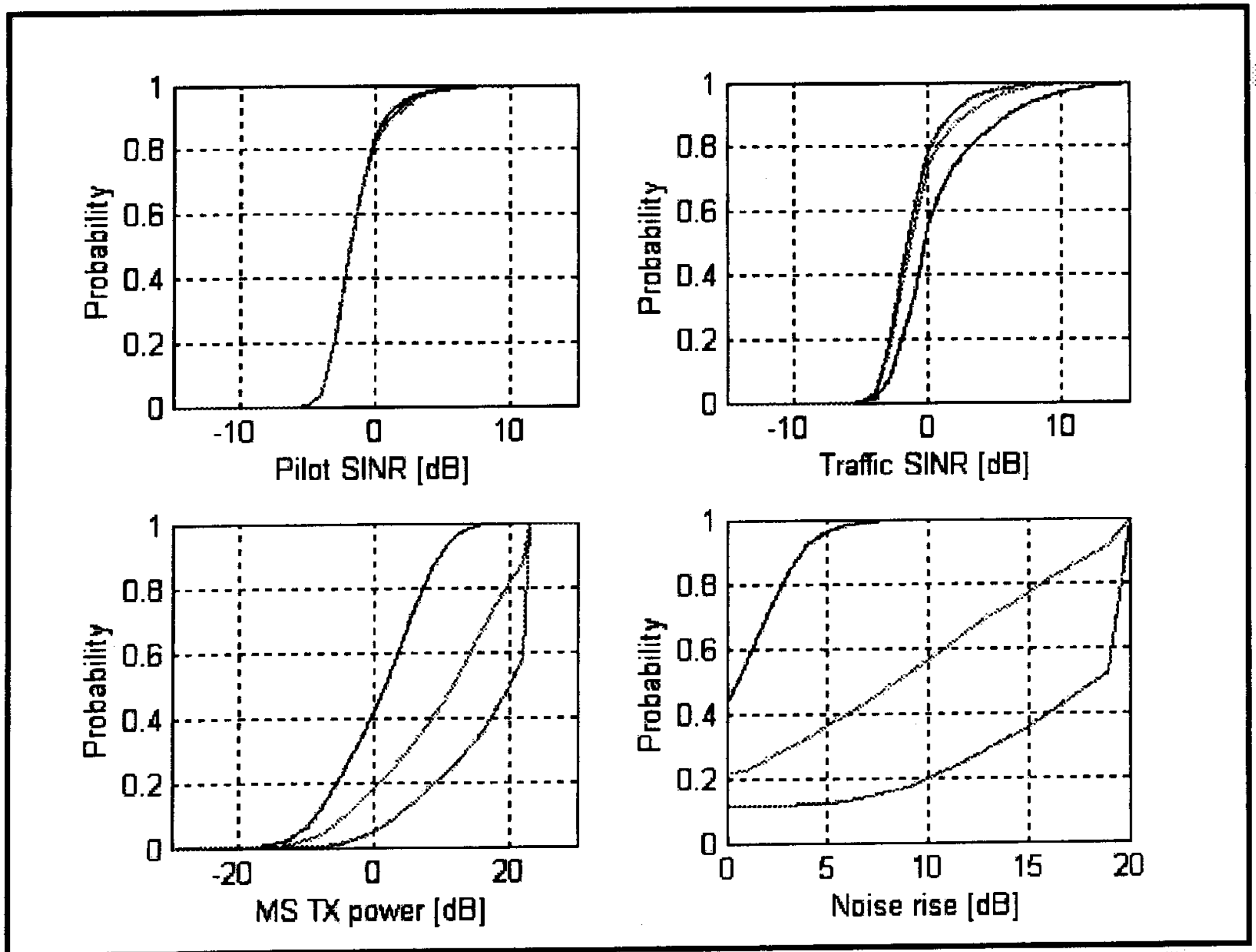
	25% loading			50% loading			75% loading		
Percentile	10	50	90	10	50	90	10	50	90
Pilot *SINR* [dB]	-1.5	2.2	6.0	-1.5	2.2	6.0	-1.5	2.2	6.0
Traffic *SINR* [dB]	0.0	4.9	11.0	-1.0	3.0	7.0	-1.2	2.5	6.0
MS TX Power [dBm]	6.0	11.0	15.0	7.0	12.5	17.0	10.0	15.0	20.0
Noise rise [dB]	0.0	1.0	2.0	1.0	2.5	4.2	3.8	5.5	8.2

Switching with 12 beams

	25% loading			50% loading			75% loading		
Percentile	10	50	90	10	50	90	10	50	90
Pilot *SINR* [dB]	-1.6	2.0	5.5	-1.5	2.0	6.0	-1.5	2.0	6.0
Traffic *SINR* [dB]	11.0	19.0	24.0	9.0	18.0	24.0	7.0	17.0	23.0
MS TX Power [dBm]	6.0	11.0	14.0	6.0	11.0	15.0	6.0	13.0	18.0
Noise rise [dB]	0.0	1.0	2.0	0.2	1.5	3.0	1.0	3.0	6.0

All performance indicators are within the boundaries of normal 1xEvDO operation

Results – Airport scenario [40%]



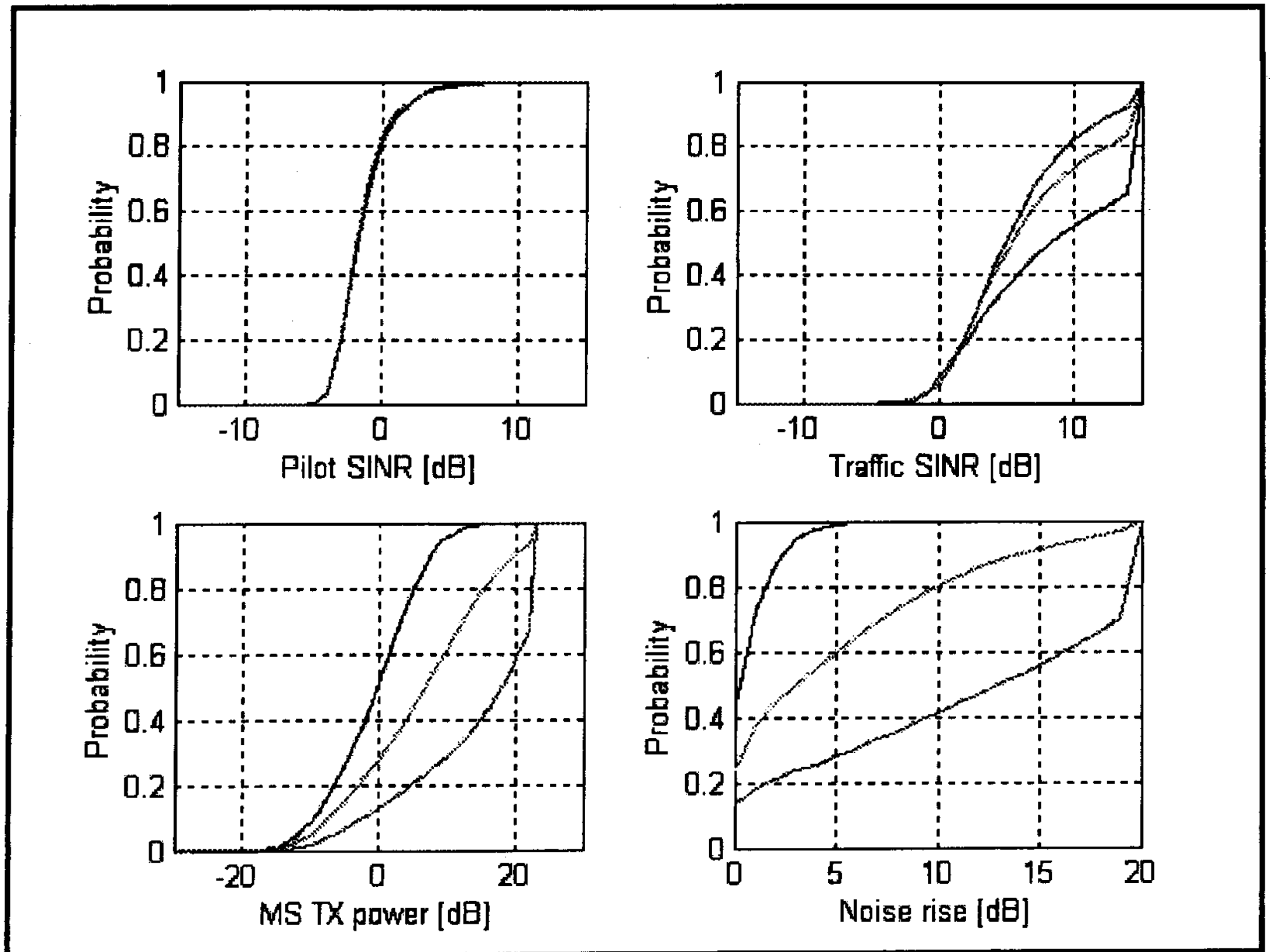
Airport – 1 beam per cell (sector), 40% spectrum overlap, blue – 25% loading, green - 50% loading, red – 75% loading

- Polarization isolation – 12dB
- 25% loading – 12 aircraft/system
- 50% loading - 24 aircraft/system
- 75% loading – 36 aircraft/system
- Used –20dB null fill antennas

Loading [%]	# of aircraft
25	48
50	96
75	144

Results – Airport scenario [40%]

AirCell



Airport – 4 beam per cell (sector), 40% spectrum overlap, blue – 25% loading, green - 50% loading, red – 75% loading

- Polarization isolation – 12dB
- 25% loading – 12 aircraft/system
- 50% loading - 24 aircraft/system
- 75% loading – 36 aircraft/system
- Used –20dB null fill antennas

Loading [%]	# of aircraft
25	48
50	96
75	144

Results - summary of airport scenario -20dB null fill

AirCell

No beam switching

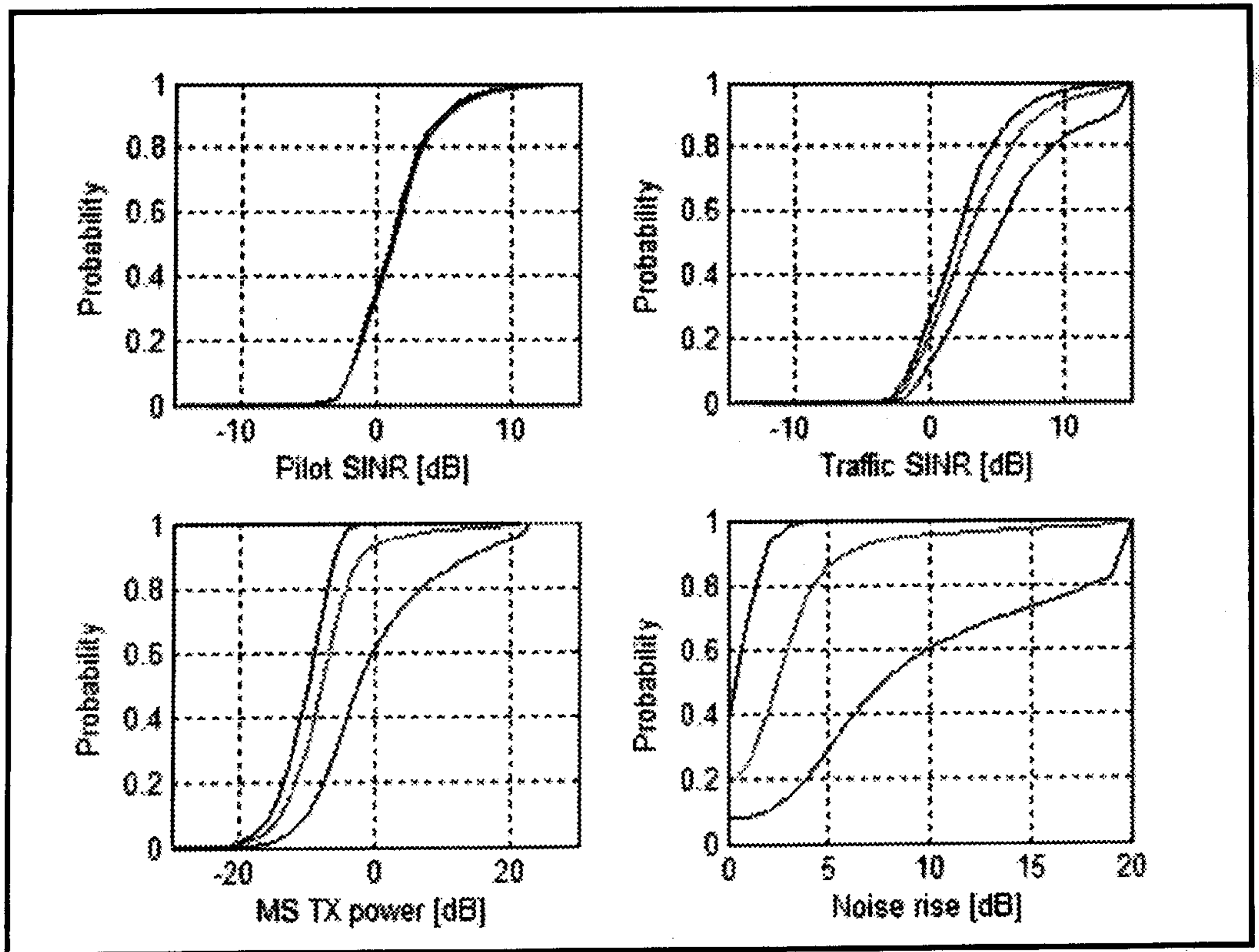
	25% loading			50% loading			75% loading		
Percentile	**10**	**50**	**90**	**10**	**50**	**90**	**10**	**50**	**90**
Pilot *SINR* [dB]	**-3.0**	**-1.0**	**1.5**	**-3.0**	**-1.0**	**2.0**	**-3.0**	**-1.0**	**2**
Traffic *SINR* [dB]	**-2.0**	**0.0**	**6.0**	**-3.0**	**-1.0**	**3.0**	**-3.0**	**-3.0**	**-1.0**
MS TX Power [dBm]	**-8.0**	**2.0**	**10**	**-4.0**	**12.0**	**22.0**	**4.0**	**21.0**	**23.0**
Noise rise [dB]	**0.0**	**1.5**	**4.0**	**0.0**	**9.0**	**19.0**	**0.0**	**19.0**	**25**

Switching with 4 beams / sector

	25% loading			50% loading			75% loading		
Percentile	**10**	**50**	**90**	**10**	**50**	**90**	**10**	**50**	**90**
Pilot *SINR* [dB]	**-3.0**	**-1.5**	**2.0**	**-3.0**	**-1.5**	**2.0**	**-3.0**	**-1.5**	**2.0**
Traffic *SINR* [dB]	**1.0**	**9.0**	**24.0**	**1.0**	**5.0**	**18.0**	**1.0**	**5.0**	**14.0**
MS TX Power [dBm]	**-9.0**	**0.0**	**18.0**	**-6.0**	**6.0**	**20.0**	**-2.0**	**18.0**	**23.0**
Noise rise [dB]	**0.0**	**1.0**	**3.0**	**0.0**	**4.0**	**15.0**	**0.0**	**13.0**	**24.0**

For 75% of loading, interference becomes to high

Results – Airport scenario [40%] - 4

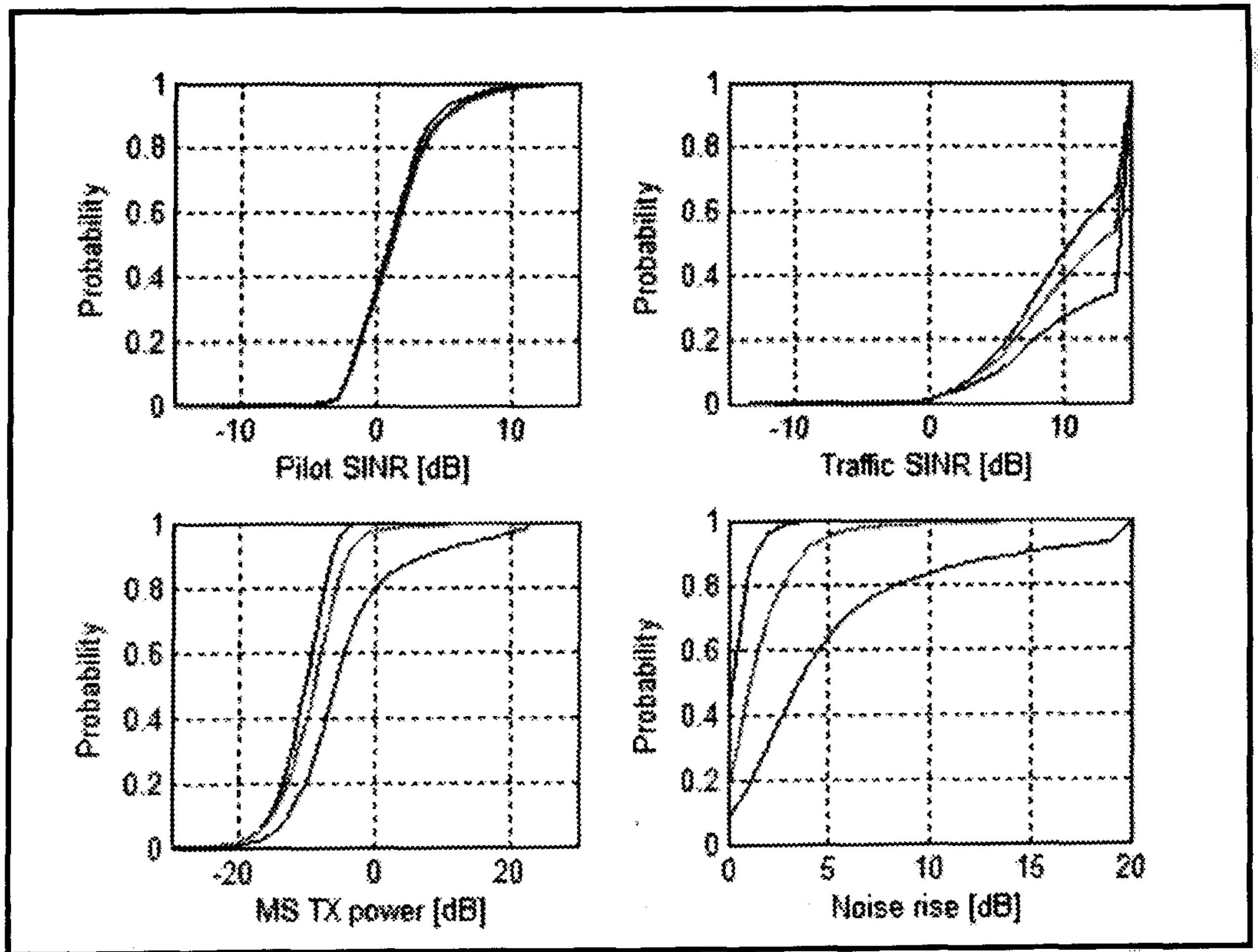


Airport – 1 beam per cell (sector), 40% spectrum overlap, blue – 25% loading, green - 50% loading, red – 75% loading

- Polarization isolation – 12dB
- 25% loading – 12 aircraft/system
- 50% loading - 24 aircraft/system
- 75% loading – 36 aircraft/system
- Used 0dB null fill antennas

Loading [%]	# of aircraft
25	48
50	96
75	144

Results – Airport scenario [40%] - 6



Airport – 4 beam per cell (sector), 40% spectrum overlap, blue – 25% loading, green - 50% loading, red – 75% loading

- Polarization isolation – 12dB
- 25% loading – 12 aircraft/system
- 50% loading - 24 aircraft/system
- 75% loading – 36 aircraft/system
- Used 0dB null fill antennas

Loading [%]	# of aircraft
25	48
50	96
75	144

Results - summary of airport scenario 0dB null fill

No beam switching

	25% loading			50% loading			75% loading		
Percentile	10	50	90	10	50	90	10	50	90
Pilot *SINR* [dB]	-1.5	2.0	6.0	-1.5	2.0	6.0	-1.5	2.0	6.0
Traffic *SINR* [dB]	0.0	5.0	14.0	-1.5	3	8.0	-1.5	2.0	7.0
MS TX Power [dBm]	-5.0	-10	-6.0	-4.0	-8.0	-2.0	-10	-2.0	15
Noise rise [dB]	0.0	1.0	3.0	0.0	3.0	7.0	2.5	8.0	25.0

Switching with 4 beams / sector

	25% loading			50% loading			75% loading		
Percentile	10	50	90	10	50	90	10	50	90
Pilot *SINR* [dB]	-1.5	2.0	5.0	-1.5	2.0	5.5	-1.5	2.0	5.5
Traffic *SINR* [dB]	6.0	20.0	38.0	4.00	13.0	29.0	4.0	11.0	24.0
MS TX Power [dBm]	-16	-10	-6.0	-16	-8.0	-4.0	-12	-5.0	8.0
Noise rise [dB]	0.0	1.0	2.0	0.0	2.0	4.0	0.0	4.0	16.0

For 75% loading interference is manageable

Observations and conclusions

- Four systems can operate in ATG band
- Interference isolation between systems obtained through
  - Spectrum swapping
  - Polarization isolation
  - Partial spectrum overlap
- In cross-country scenario – no advanced hardware required
- In airport scenario
  - Null filled antenna patterns improve performance
  - Switch beam antennas may be required at very higher loading
- Additional hardware improvement (switch beam base antennas, beam forming aircraft antennas) – may reduce interference even further